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EDITORIAL

STEPS IN THE ADVANCE OF SURGICAL PRACTICE

DURING the last two decades great advances have been made in the science and art of surgery, so that almost every part, and, indeed, tissue, of the animal body may now come within the purvue of the surgeon. The art and craft of surgery is as old as recorded history, and there is evidence that intricate and delicate operations, such as the trepanning of the cranium, were performed many thousands of years ago.

The available evidence of the daring adventures of these surgeons of yore lead one to assume that the operators were skilful technicians. One could also presume that their patients either made a rapid recovery or, as quite well may have been the case, they did not survive for long enough to make a permanent record on bone of the gross effects of inflammatory reaction and suppuration. Until the 19th century a surgeon had to be a man of great courage and determination, and, above all, a man who could control his emotions in the face of pain and suffering, for the great blessing of general anæsthesia had not arrived.

Speed, dexterity and a profound knowledge of anatomical detail were his greatest assets. Craftsmanship reigned supreme. The technique of the various operations were laid down to the utmost detail and memorised so that he could act, almost automatically, according to a set plan. Such was their precision that a limb, or a part thereof, could be amputated by a few deft strokes of the knife and in a few seconds. Until quite recent times surgical textbooks laid great emphasis on these points, and the illustrations depicted the position and the passage of the knife during the various phases of the operation.

(The May issue of The British Veterinary Journal was published on May 15)

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The introduction of general anæsthesia by the aid of chloroform and ether was the first great landmark in the approach to modern surgery. Pain and suffering were swept away and great speed in action was no longer essential. The next landmark was the acceptance of the germ theory of disease, and when Lister demonstrated how this new conception could be called to the aid of the surgeon the way was clear for surgery to advance to the status of a science instead of just being a craft.

With the advance in bacteriological knowledge it was almost inevitable that the aseptic technique should replace Lister's original antiseptic methods. This led to a complete revolution in the regimen of the operating theatre. The success of an operation now depended upon the integrity of the so-called antiseptic chain. Breakdown did occur, for man is not infallible.

Many and constant were the attempts to prevent such breakdowns, and from time to time antiseptics were introduced in the hope that by a judicious combination of aseptic and antiseptic techniques a fool-proof system might evolve and calamity be avoided.

The best answer came in quite recent times, when the sulpha drugs were introduced, to be succeeded later by the antibiotics. By their aid surgery has been bereft of its most potent dangers.

Now, all these wonderful changes are associated with the surgeon, but the man at the head of the table, the anæsthetist, did not keep pace with his colleague.

The shape of the mask and the container might alter a little, according to some individual's whim, but by and large he used the same agents and in the same way as his grandfather had done in former years.

Then all at once the chemists presented the barbiturates and new types of vapour anæsthetics, and the instrument designers produced the positive pressure and other machines. The anæsthetists became thoroughly awake and the surgeons prodded them to further efforts, for every advance in anæsthesia widened the horizon of their endeavours.

The new methods employed to induce anæsthesia constitute the modern revolution in surgical practice. New discoveries come surging on to us. One of these is a vapour anæsthetic, cyclopropane-oxygen. Its use in horses is discussed in this issue of the BRITISH VETERINARY JOURNAL.

Veterinary surgeons are quick to note any new methods which are employed successfully in human surgery and which can be applied with safety and humanity to their animal patients. The barbiturates serve as a striking example of this adaptation, and they are used extensively in small animal practice. They have not met with the universal approval of the large animal men. It may be that cyclopropane or some other modern vapour anæsthetic will find a place in the armamentarium of the large animal practitioner. The results recorded give great hope.

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GENERAL ARTICLES

A NEW ANÆSTHETIC TECHNIQUE FOR THE HORSE:

A Preliminary Note on the Use of Cyclopropane-Oxygen Anæsthesia

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In this note we draw attention to a method for inducing a state of general anæsthesia in horses which may have a future in equine practice.

In making radiological examinations of the trunk and upper parts of the limbs of ponies it was necessary to be able to place the animal on a Potter-Bucky pouch and to position it there with the minimum of restraint. For this purpose we required an anæsthetic which would comply with the following conditions:—

(1) It must be safe—a risk perhaps acceptable in the performance of a major surgical operation is not justified in the course of a clinical examination.

(2) It must be suited to the confined space of an X-ray room. There must be no large casting bed required and induction must be smooth and free from struggling, with risk to the animal and to the apparatus.

(3) It must be possible to maintain anæsthesia at a level that permits free manipulation of the subject for prolonged periods. Until techniques are standardised repeated exposures, with scrutiny of the plates after each, will be required.

(4) It is desirable to have provision for the suspension of the respiratory movements for the several seconds necessary to make exposures.

(5) There must be a minimum of equipment obscuring the animal and hindering free alteration of position.

(6) It must be possible to terminate anæsthesia immediately the examination is completed.

(7) Recovery should be rapid and uneventful.

These rather exacting requirements are not met by any of the agents in current use in equine anæsthesia, and, searching for an alternative method, we were guided by the fortunate experience some of us have had with cyclopropane-oxygen anæsthesia in other species to investigate the possibility of adapting this method to the horse. Our first results when using cyclopropane in connection with radiological examinations were so satisfactory that we continued its use

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for this purpose, and also tried the method on the few surgical cases which came our way.

In this preliminary account we base our observations on a short series of 14 cases, all ponies or donkeys. Of these animals, 10 were anæsthetised for radiological and four for surgical purposes (three castrations, one minor interference); all were in good or moderate condition and were free from respiratory or circulatory disease. They ranged in age from eight months to 15 years, and in weight from 150-700 lb.

Cyclopropane-oxygen anæsthesia has been used in human anæsthetic practice for some time, and in recent years had quite extensive employment in small animal surgery. The properties of the gas and the general technique of its use are therefore familiar and need not be described in detail in the present connection.

Apparatus

Because of the comparatively high cost and explosive nature of cyclopropane, this gas must be administered, mixed with oxygen, in a closed-circuit anæsthetic apparatus that permits total rebreathing. The apparatus available to us was a Heidbrink anæsthetic machine, previously modified for the administration of cyclopropane-oxygen anæsthesia, and which only required the substitution of a larger (1 gallon) rebreathing bag to be suitable for equine anæsthesia. The features of this apparatus are well known and are described in the standard textbooks of anæsthesia: the essential points are the completely closed circuit of the circle type, a rebreathing bag on the inspiratory side of the circuit, a soda-lime canister providing variable CO_2 absorption, and provision for the direct inflation of the lungs with oxygen. The apparatus is connected by a Y-piece to a cuffed endotracheal tube (Hewer's modification of Magill's). These tubes should be available in several sizes so that one may be selected that provides the maximum airway possible; if the oral rather than the nasal route is used the size of the trachea is the limiting factor. Convenient sizes for the animals in our series were: 70 cm. in length and 2 cm., 2.6 cm., and 3 cm. in external diameter.

Administration and Course of Anæsthesia

The animal is prepared by fasting for 18 hours; no premedication is necessary.

In the place where it is proposed to induce anæsthesia, the animal is backed into a padded corner. A site for jugular puncture is prepared in the usual way and anæsthesia is induced by the rapid intravenous injection of a minimal calculated* dose of "Sagatal." After an interval of a few seconds the animal sinks

*The dose, surprisingly small, is calculated according to weight—14 c.c. is sufficient, in our experience, for a 240 lb. pony, but more investigations on this point and on the influence of age and condition are required.

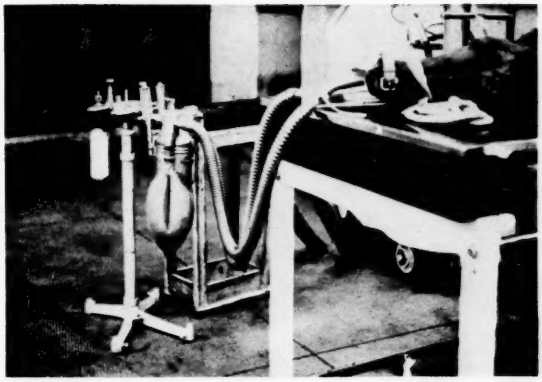

FIG. 1
General view of the apparatus in use.

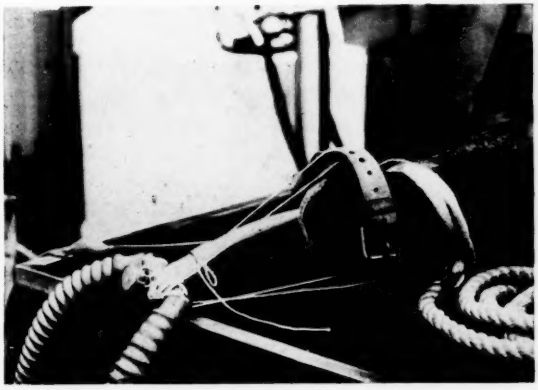

FIG. 2
Gag and tube in position

(*Article by Dyce, page* 187).

to its haunches and almost immediately rolls on its side; there has been no struggling or excitement in any animal in our series. This injection provides 5-10 minutes of gradually lightening anæsthesia—ample time for passage of the endotracheal tube and connection to the anæsthetic apparatus.

The pony is now secured, and, if desired, a small animal may be transferred to a Potter-Bucky couch or to an operating table. The endotracheal tube is now inserted: the head and neck are extended and the tube is passed through the mouth and larynx for some distance into the trachea before the cuff is inflated. A probang gag may be used to protect the tube from the teeth and to assist in holding it in position.

The rebreathing bag is filled with oxygen and the apparatus is connected to the tracheal tube. At this stage the animal is generally showing some signs of recovering from the injection, and the first quantity of cyclopropane should be added to the circuit; during the next few minutes further quantities of cyclopropane are added until the desired level of anæsthesia is obtained. Theoretically, as there is complete rebreathing, anæsthesia could be maintained at this level indefinitely without administering additional anæsthetic: in practice further quantities must be given to compensate for loss by leakage from the system and elimination from the animal by portals other than the lungs. It is a simple matter to vary the depth of anæsthesia: deeper anæsthesia is obtained by increasing the proportion of cyclopropane in the gas-oxygen mixture; lighter anæsthesia by releasing some of the mixture from the circuit and restoring the volume with oxygen. Oxygen must, of course, be added either continuously or in frequent bursts to keep pace with utilisation and to maintain the volume of gas in the circuit.

We have not as yet recorded detailed observations on the development and course of anæsthesia. A pony of 240 lb. requires $1\frac{1}{2}$-$1\frac{3}{4}$ litres of cyclopropane within the first few minutes after transference to the closed circuit, and uses a similar quantity hourly to maintain anæsthesia at this level. The initial dose was increased by about 50 per cent for the production of the deeper anæsthesia required for the castration operations.

So far as we can at present judge, cyclopropane has no undesirable effect on the respiration and is without any marked effect on the circulation. The reflexes, notoriously unreliable in the horse, are affected in the conventional order.

A valuable feature of the method is the means of controlling the rate and depth of respiration by varying the amount of expired gas that passes through the soda-lime canister, and therefore the percentage of carbon dioxide in the inspired gas. With some experience the machine can be set so that little adjustment is necessary. A further advantage is the ease with which the abdomen and thorax can be immobilised for periods sufficiently long to enable radiographs of these parts to be made. This is achieved by exerting manual pressure on the inflated rebreathing bag sufficient to overcome the expiratory movement.

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There is, however, a certain risk that incautious inflation may develop an excessive pressure within the lungs with the possibility of emphysema occurring—this complication has occurred in man, and the predisposition of the horse to this condition suggests a similar danger.

On completion of the operation or examination the supply of cyclopropane is cut off and the circuit gradually opened to the air before the apparatus is disconnected. Any hobbles may be removed at this stage, and if on a table the animal should be transferred to the floor. The tube is retained in position until consciousness returns, as so long as it occupies the trachea there is no possibility of obstruction of the upper respiratory passages. After a few minutes consciousness will have returned sufficiently for the tube and gag to be removed with safety: recovery is now rapid. Within 10 minutes of anæsthesia being discontinued the animal will be supporting itself on its brisket, and another 10-15 minutes is sufficient to see it on its feet. Muscular co-ordination returns quickly and the pony may be safely returned to its box within 20-30 minutes from the termination of anæsthesia. Provided the animal is permitted to recover in its own time and is not forced to its feet too soon, there is no sruggling or excitement.

We know of no ill-effects resulting from the anæsthesia, and this despite prolonged anæsthesia on a number of occasions. One pony has been lightly anæsthetised for upwards of two hours on three occasions within a fortnight without any apparent ill-effects.

Discussion

Any observations we make on the basis of our present experience are subject to the reservations entailed by the small number of cases, the size of the animals and the depth of anæsthesia employed. None the less, our experience within these limitations has been so satisfactory that we have no hesitation in stating that the results we obtained could not have been achieved with any other anæsthetic technique, and in particular the way now lies open for radiological investigations of parts previously considered inaccessible to the radiologist. The advantages of cyclopropane will be apparent since it fulfills the requirements laid down in the introduction to this paper.

The more general interest will no doubt be in the application of cyclopropane anæsthesia to surgery for the horse. Here we would be more cautious, as our experience is so slight and as we have never attempted deep surgical anæsthesia. We see no reason to doubt that deeper anæsthesia than that we have required could be obtained with this method, but if this should be unsatisfactory, provision exists for the inclusion in the circuit of an ether or chloroform bottle that could be brought into use when it was necessary to augment the level of anæsthesia. These, however, are questions that must await more extensive

investigations by others more experienced in equine anæsthesia before they can be profitably answered. It is to be hoped that the results will fulfill the early promise.

Acknowledgments

We are grateful for this opportunity of expressing our thanks to those who have helped us; to Professor McCunn for permission to conduct this work in his department and for his advice and encouragement; to R. H. A. Merlen, M.R.C.V.S., for much generous assistance; to Messrs. S. J. Bryant, T. Crosby, C. A. Fowler and C. P. Levey for technical assistance, and in particular to Mr. Bryant for the design and construction of the gag; to Messrs. W. T. Price and F. Roberts for the care of the animals ; and to Mr. R. Shepherd for the photographs.

THE OCCURRENCE OF BLOOD FILAMENTS OR "PSEUDO-SPIROCHÆTES" IN CERTAIN NEOPLASTIC CONDITIONS

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WHEN fresh blood is examined by dark-ground illumination, a number of filamentous objects may be seen which have, in the past and even quite recently, led to errors in diagnosis through misinterpretation. It is surprising that no reference is made to these structures in any of the current textbooks of hæmatology so far consulted.

The first mention of such filaments appears to be by Nuttall and Graham-Smith (1907) in one of their classical papers on piroplasmosis. They found filaments, extruded vesicles, and beaded structures in the blood of dogs, and at first they considered them to be parasites. Later, filaments were also found in the blood of various animals including the fowl. Nuttall and Graham-Smith concluded that these objects are degeneration products of red blood corpuscles, supporting this contention by showing that the production of filaments could be enhanced by warming the blood above its physiological temperature, and they appended some good drawings of typical structures.

Kuhn and Steiner (1917) studied these filaments, claiming that they were spirochætes and were the cause of multiple sclerosis. They described them as often more delicate than Weil's organism, some showing a loop, and others a highly refractile ball at each end. They claimed to have transmitted the

condition to guinea-pigs and rabbits. Collins and Noguchi (1923) also experienced a preliminary difficulty in the interpretation of these structures. They state that they are abundant in blood kept at room temperature, and that there are many free-swimming forms not attached to erythrocytes. They were not stainable by Giemsa's stain, but occasionally by Loeffler's flagella stain, and were undoubtedly derived from altered red corpuscles.

Thomson (1923) records their presence in normal human blood and describes two kinds of filaments, the first being thick, motile, and 5 to 9 μ in length, and the second longer (7 to 12 μ) and extremely delicate. They exhibit no spiral movement but are actively motile (?), wriggling and bending upon themselves. He found that they may assume a spiral shape on fixing and drying. They normally show no coils or spirals, and occasionally exhibit a beaded appearance. Similar structures in the blood are mentioned by Adams *et alia* (1925).

Baer and Allen (1944) drew attention to these filaments, which they had observed in their study of cases of leptospirosis, and warned against their confusion with true spirochætes. Kuzell (1945) speaks of artificial spirochætes in cases of infective hepatitis, and the possibility of their misinterpretation; while Simmons (1946) and Gowen (1946) also mention "pseudo-spirochætes" as a source of diagnostic error. Schmidt (1947) likewise describes spirochæte-like formations which he found in the blood of patients and in normal persons.

Similar structures to these have been encountered in the course of recent work at this Centre. They were originally found in profusion in the fresh blood of fowls infected with a virus-associated erythroleukæmia, but could not be seen in fresh normal fowl's blood. They make brilliant objects with dark-ground illumination and an oil-immersion objective (Fig. 1), are easily detectable with phase contrast, but are extremely difficult to see with ordinary transmitted light. They have been stained with Giemsa's stain, but Levaditi's method, osmic acid, Feulgen's stain, and brilliant cresyl blue all failed to show them in dried films.

Subsequently, similar structures have been observed in normal fowl's blood which has been kept for 12 to 24 hours at room temperature and has been sealed under sterile conditions in Vaseline on slides. The longer these preparations are kept, the more numerous the filaments become. Typically, they appear as tenuous filaments of varying width and from 3 or 4 μ up to 30 μ in length, usually attached to a pole of an erythrocyte, and occasionally appearing to arise from the region of the nucleus. The point of attachment is marked by a bright refractile granule (Fig. 2) and a similar granule is often to be seen at the free end. They may branch, or several may be attached to one cell, and they are often seen floating freely in the plasma, fluttering and bending but certainly not exhibiting any spontaneous motility. On several occasions a long filament has been observed to contract suddenly and then form a small vesicle with "pseudopodia" adhering to an erythrocyte (Fig. 3).

A less common structure is shown in Fig. 4. It is beaded and is always

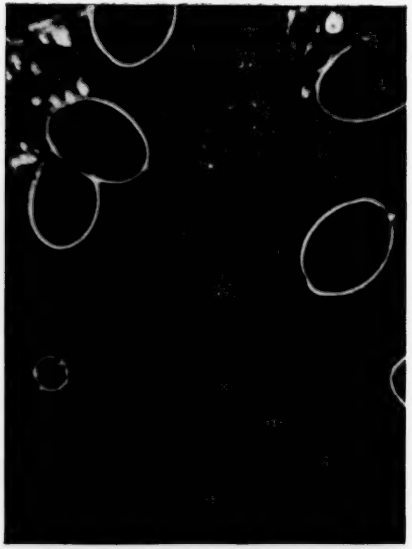

FIG. 1

An example of a long free filament. Fresh blood from a case of erythroleukæmia in a 7-week-old chicken. Dark-ground illumination × 2,800.

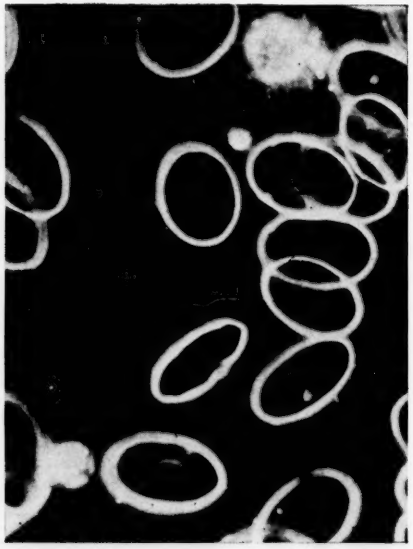

FIG. 2

A branched filament attached to an erythrocyte. The double contour and forked extremities are artefacts due to movement during exposure. Erythroleukæmia blood, D.G.I. × 2,800.

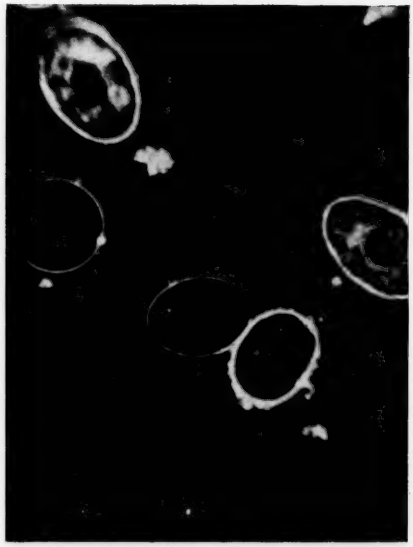

FIG. 3

A vesicle with pseudopodia projections attached to an erythrocyte. This structure was originally a long filament comparable to that shown in Fig. 1. Erythroleukæmia blood. D.G.I. × 2,800.

(*Article by Campbell, page 191*).

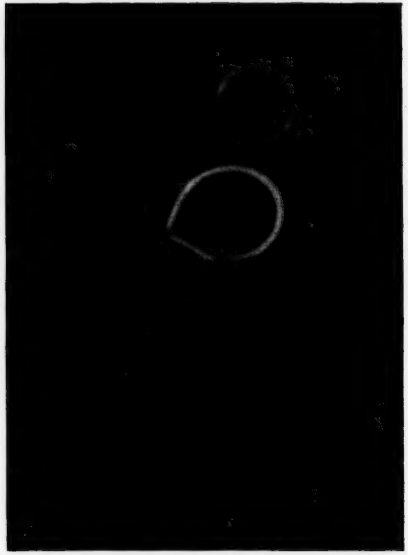

FIG. 4

A beaded filament attached to an erythrocyte. Note the larger granule at the free extremity. Erythroleukæmia blood. D.G.I. × 4,200.

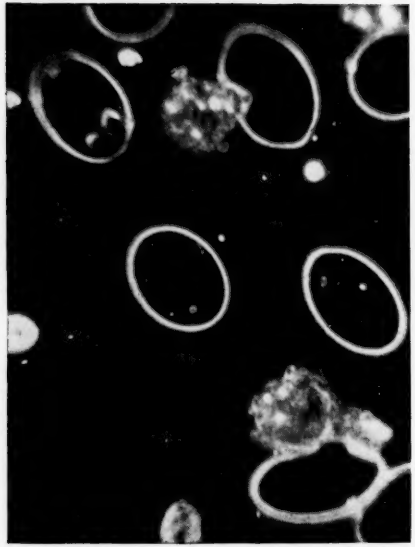

FIG. 5

A branched and beaded filament with conspicuous terminal granules within an erythrocyte. Erythroleukæmia blood. D.G.I. × 3,000.

FIG. 6

Apparent formation of a filament from the nuclear region of an erythrocyte. Movement has blurred the outlines. Erythroleukæmia blood. D.G.I. × 3,000.

terminated by a slightly larger granule. These too may branch, and may be seen apparently within an erythrocyte where, over a period of hours, they have been observed to increase in size and change their conformation (Fig. 5). On one occasion such a structure slowly disintegrated, leaving numerous dancing granules in the cytoplasm of the cell. Small tufts of beaded filaments may occur attached to a cell.

The filaments are remarkably stable, preserving their identity for many days in a sealed sterile preparation, and even increasing in number. They also show a tendency to thicken. They occur in equal abundance in heparinised leukæmic blood, or similarly treated normal blood kept at room temperature. Saponin 1 : 1,000 has no effect on them, although the cells are laked.

They are not confined to erythrocytes. Occasionally a leucocyte shows one, and some of the malignant hæmocytoblasts in leukæmic birds may carry numerous waving filaments, each with a terminal refractile granule.

The nature of these structures is not clear. In the fowl, they are frequently seen arising from the region of the nucleus. Fig. 6 shows one such apparently having its origin in a disintegrating nucleus.

Not all have this appearance, however, many being attached to quite normal-looking erythrocytes with an intact nucleus. There is no doubt that distorted or damaged cells commonly have these appendages. In successful Giemsa-stained preparations they stain a pale blue, unlike the pink reaction of the cell membrane or cytoplasm. Feulgen preparations of such tenuous filaments are probably not reliable. Osmic acid does not stain them, so they presumably do not contain much lipoidal material. Both cytoplasm and nucleoprotein can exhibit contractile phenomena, and so this criterion is not much help either.

It must be remembered that most reports of these filaments have been as the result of the examination of mammalian blood. The red blood corpuscles being non-nucleated in these animals, it is difficult to identify them with products of nuclear degeneration unless it can be shown that they arise from reticulocytes. On the other hand, it is well known that structures such as Rous sarcoma cells photographed by ultra-violet light often show a fringe of fine filaments bordering the cell, obviously of cytoplasmic origin. Blood cells in preparations of Rous tumour and in the chemically-induced G.R.C.H./15 fibro-sarcoma of the fowl also show filaments, but usually longer and thicker than these cytoplasmic threads and in every way comparable to those described in erythroleukæmic blood or in normal blood kept for several hours at room temperature.

It is quite possible that similar filamentous structures have been encountered in association with tumours in the past, and will be found also in the future. The fact that such structures are not only present abundantly wherever blood cell degeneration is going on, as in tumours, leukæmia, or jaundice, but may also be seen in normal blood or tissue cells under suitable conditions, would

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emphasise the need for caution in the interpretation of filaments attached to cells in association with certain virus infections such as fowl plague or vaccinia, in both of which "stalked forms of virus" have been reported (Bland and Robinow, 1939; Dawson and Elford, 1949; and Robinow, 1950).

I am indebted to Dr. A. W. Greenwood, Dr. J. G. Carr, and Dr. W. S. Gordon, Director of the Agricultural Research Council Field Station, Compton, for many interesting and useful discussions and suggestions.

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MYOCOPTES MUSCULINUS (KOCH) AND *MYOBIA MUSCULI* (SCHRANCK), Two Species of Mite Commonly Parasitising the Laboratory Mouse

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Introduction

THE purpose of the present paper is to call attention to two species of ectoparasites commonly found on laboratory mice, which, although well known to zoologists for over a hundred years, do not appear to be mentioned in any of the textbooks of veterinary parasitology in common use in this country, or in any periodical veterinary literature that is readily available.

The two species referred to are not closely related to each other. *Myocoptes* belongs to the family Listrophoridæ, and shows fairly close affinities with the Sarcoptidæ. *Myobia* belongs to the Cheyletidæ, one of the families of the Prostigmata. Both species, however, are adapted to the same ecological niche, inhabiting the fur of the host, so that in their manner of life they have more

in common with the lice than with the mange-mites which live on or below the surface of the skin. In both species one or more pairs of legs are modified to form hair-clasping organs, and the eggs are laid attached to the hairs of the host.

Materials and Technique Used

The specimens on which the following descriptions and figures are based were collected from various batches of white mice bred in the Veterinary Laboratory at Nicosia, Cyprus. Some surplus male mice kept in a small and somewhat overcrowded cage were noticed to be "mangy." The symptoms were a reddening of the skin and falling out of the hair, commencing at the back of the neck and crown of the head, and spreading over the shoulders and back. Scrapings revealed large numbers of mites, subsequently identified as *Myocoptes musculinus* (Koch). When the mice were removed to a better-ventilated cage, symptoms ceased and the hair rapidly grew again. Subsequently, similar symptoms were seen in other cages of the same colony, and the mite was found abundantly not only in the affected animals, but also in others where no symptoms were shown at all. It appears that these mites can occur even in large numbers without doing harm, but that they can set up symptoms of mange when the host-parasite balance is temporarily upset, either by undue multiplication of the parasites or by diminished resistance on the part of the host. This species occurred on all parts of the body.

Myobia musculi were found in a separate colony of mice bred in the same laboratory from stock obtained from a different source. These mites were present in much smaller numbers than the *Myocoptes,* and were confined to the head and neck. At first no *Myocoptes* were present in this batch of mice, but shortly after observations commenced, infection took place and spread rapidly. The *Myocoptes* appeared to wipe out the *Myobia,* none of which were seen for a further seven months, after which they began to reappear, but always in smaller numbers. A few *Myobia* were also found attached to the eyelashes of two house-mice trapped near the laboratory.

The mites were examined both alive and when mounted by a very simple technique evolved in the laboratory, which gave satisfactory permanent preparations with a minimum of handling. Mites were removed from the host with a needle and placed on a glass slide. A coverslip was placed on top and a drop of beechwood creosote run in underneath. This procedure killed, fixed, cleared, and dehydrated the specimen. The weight of the coverslip gave sufficient pressure to ensure that the legs were extended at the time of death. Dropping into creosote often curled up the legs of the specimen. After a few hours the specimens were ready for examination. For permanent preparations, they were left a few days, which hardened them. Fresh creosote was added to remove any soluble products which might have soaked out of the specimen, and this was washed away with a little Euperal Essence. The specimens could then be mounted in euparal without any curling up of the legs. It was found, however,

Myocoptes musculinus (Koch). Eggs attached to hair.

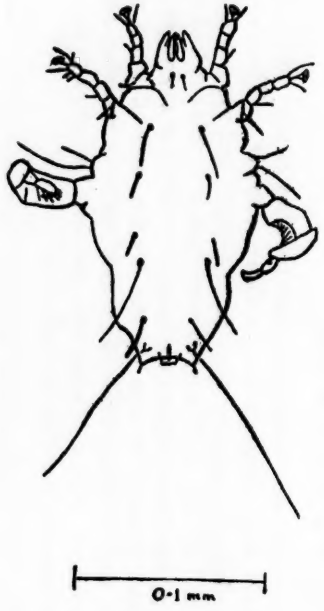
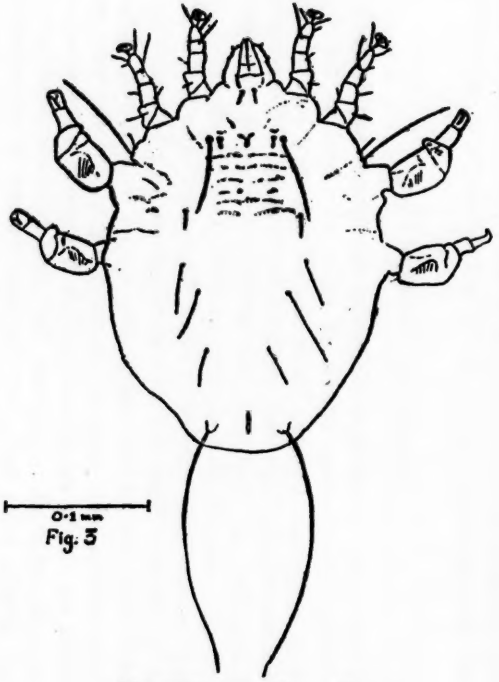
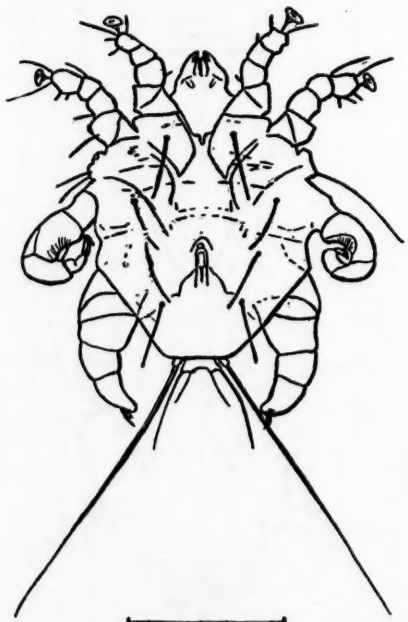


Fig. 2

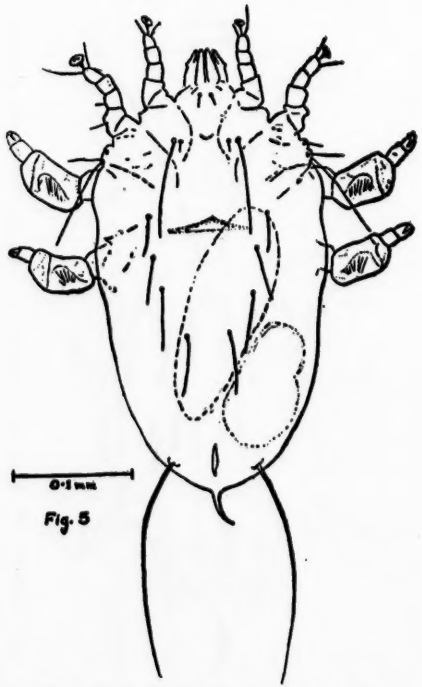
Myocoptes musculinus. Larva.



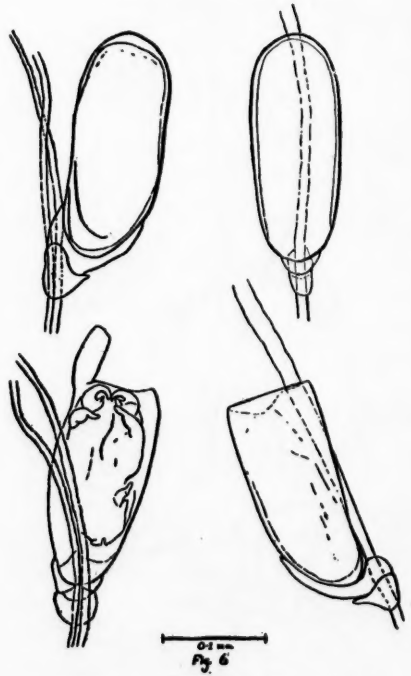
Myocoptes musculinus. Nymph.



Myocoptes musculinus. Adult male.



Myocoptes musculinus. Adult female.

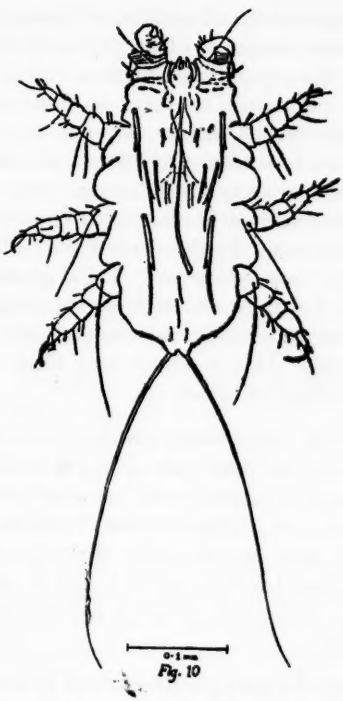


Myobia musculi (Shranck). Eggs, as laid, hatching, and empty.

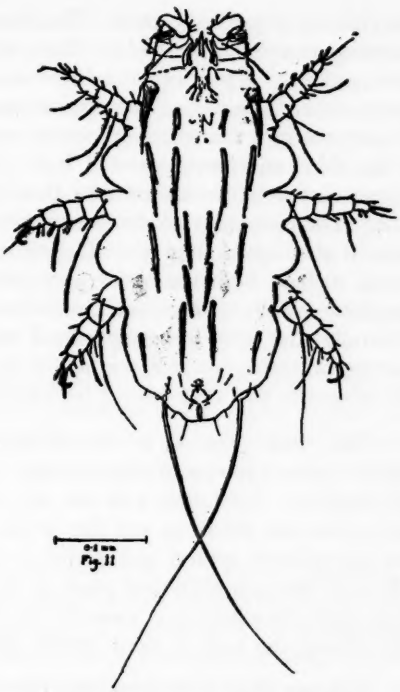
Myobia musculi. Larva.

Myobia musculi. Nymph.

Nymph of some other species of *Myobia* or related genus.



Myobia musculi. Adult male.



Myobia musculi. Adult female.

All specimens are viewed dorsally, but in some instances the transparency of the specimen has allowed genitalia, etc. on the ventral surface to be indicated.

that the eggs were best studied in creosote, as they underwent great distortion, or even total destruction, when transferred to euparal. Specimens were drawn by the aid of a Zeiss camera lucida under a 1/6″ objective. Details were checked under a 1/12″ oil-immersion objective.

Descriptions of Species

Myocoptes musculinus (Koch). (Figs. 1-5.) The adult female is oval in shape, measuring 330-380 μ by 155-210 μ. The general appearance, especially that of the mouthparts and the first two pairs of legs, is not unlike that of a *Psoroptes* or *Chorioptes*. The legs are five-jointed, and in the first two pairs the last joint carries a sucker on a short, unjointed pedicel. In the third and fourth pairs the second and third joints are dilated, heavily chitinised, and fused to form a hair-clasping organ. The ventral aspect of these joints is concave and the inner surface striated, giving a firmer hold on the hair of the host. The last two joints are smaller and can be folded back on the dilated portion to close

the clasping organ so formed. The anus is ventral and slightly in front of the posterior margin of the body. The posterior margin is often produced into a short process. A pair of caudal setæ arise from papillæ at the hind end of the body, either terminal or subterminal and ventral. The vulva is a transverse slit situated in a triangular depression on the ventral surface, between the bases of the third and fourth pairs of legs. There is a trifid tubercle on the lateral margin between the second and third pairs of legs, which carries three stiff setæ. The chætotaxy of the dorsal surface need not be described, but can be seen in the figure (Fig. 5). The cuticle is scaly in the central part of the dorsal surface, with the scales arranged in transverse rows. These gradually merge posteriorly into transverse striations. Laterally, the striæ are longitudinal. Ventrally, the striæ are longitudinal posteriorly, parallel to the anal slit, but curving outwards towards the lateral margins. In the central area these striæ are transverse and bear minute backwardly-directed spines.

The male (Fig. 4) is very different in appearance, smaller, measuring 195-215 μ by 140 μ, and more robust. Only the third pair of legs is modified for clasping. The fourth pair are very stout. The setigerous tubercle between the second and third legs and the caudal setæ are similar to those of the female, but immediately ventral and medial to the latter are two pairs of shorter setæ. There is a strongly chitinised penis on the ventral surface which is plainly visible even when the specimen is viewed dorsally. The whole cuticle is heavily chitinised, giving the body a deep brown colour.

The egg (Fig. 1) is elongated, 195-215 μ by 40-45 μ, and is laid in a loose envelope attached to the hair and open at one end.

The larva (Fig. 2) is small and louse-like, 170-220 μ by 100-130μ, with suckers on the first two pairs of legs and claspers on the third.

The nymph (Fig. 3) is similar to the adult female, but smaller and more rounded, measuring 260-285 μ by 175-180 μ.

Myobia musculi (Schranck). The adult male (Fig. 10) and female (Fig. 11) are similar to each other in general appearance, differing only in chætotaxy and genitalia. The first pair of legs, modified into clasping organs, are short and stumpy, point forwards, and are closely applied to the mouthparts. The joints of these legs are more or less fused and carry a claw-like tubercle articulating with the antero-dorso-medial part, and closing downwards, backwards and outwards on to a striated, shelf-like projection, quite unlike the condition seen in the larva and nymph. The body is approximately twice as long as broad, and the lateral margin forms a distinct bulge between each pair of walking legs. The female measures 390-495 μ by 190-260 μ, and the male, 285-320 μ by 145-175 μ. The second, third and fourth pairs of legs are five-jointed, and the end joint bears a prominent claw. The anus is dorsal. The penis of the male is a long, thread-like structure situated internally for most of its length, originating about the level of the fourth pair of legs and reaching the exterior in a

depression on the dorsal surface, level with the second pair. A pair of caudal papillæ, bearing long setæ, are situated, in the male, close together at the posterior margin. In the female the posterior end of the body is more prominent, the caudal papillæ and setæ being more widely separated and situated subventrally. The anus is in contact with the posterior margin, and the vulva is just above it, flanked by two small hooks and a few bristles. The dorsal surface bears a series of large, slightly-flattened and fluted setæ pointing backwards, most of which are bifurcated posteriorly to form a short barb and a longer flagellar portion. In the female there are five submedian pairs, only the first two of which are barbed, and four lateral pairs, the first of which is extremely stout and horny. In the male they are rather fewer and differently arranged, and the first lateral pair are not stout and horny like those of the female.

The eggs (Fig. 6) are oval, and measure 200-235 μ by 70-90 μ. They are attached to the hair of the host by a flange consisting of two parts, a basal part roughly triangular and attached to the hair (or to two hairs if these are slender and happen to be close together) and a cup-like part in which the egg sits like an acorn. The larva emerges from the top of the egg through an operculum which lifts up and drops off.

The larva (Fig. 7) measures 250 μ by 160 μ and is, generally speaking, a smaller edition of the adult, rather shorter in proportion to its breadth, and with three pairs of legs, of which only the second and third are used for walking and are four-jointed. There are important differences in the structure of the mouthparts and the first pair of legs. The mouthparts are produced into a long and permanently extended proboscis, unlike the short, conical mouthparts of the adult with their fine, protrusible stylets. The clasping legs carry a claw-like tubercle, somewhat different in shape from that in the adult, articulating with the antero-dorso-lateral part, and closing downwards, backwards and inwards on to a ventro-medial shelf and a dorso-medial, thumb-like process. The dorsal chætotaxy differs from that of the adult. There is a transverse row of six setæ between the second and third pairs of legs, and two setæ just anterior to this row. From the level of the third pair of legs to the anus there are six pairs of submedian setæ, the last two pairs smaller and surrounding the anus, and a lateral pair. All these setæ are barbed. There is, in addition, the usual pair of caudal setæ at the hind end of the body.

The nymph (Fig. 8) measures 260-295 μ by 165-180 μ, and resembles the larva, except in the possession of a fourth pair of legs (also four-jointed), and in the considerably greater length of the lateral pair of setæ. There are said to be two nymphal stages, protonymph and deuteronymph, showing very little difference from one another, but only one has been observed in the present material.

At least one other species of *Myobia* was present among the earlier specimens found on these mice; and probably more than one. *M. musculi* has only a single claw at the end of each walking leg, but one of these specimens clearly showed two claws on the second pair, and is therefore probably either *M. affinis*

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(Poppe) or *M. lemnina* (Koch). Unfortunately, there is not sufficient material for a definite diagnosis. Some very minor variations in chætotaxy were noted in some of the larvæ. One nymph (the first to be found) was totally different from all those seen later. The legs are very short and the fourth pair carry a large and clearly-marked spur on the medial aspect of the penultimate segment. The chætotaxy is also quite different (Fig. 9). Nothing in any way resembling it can be found described in the literature. Dr. E. L. Taylor has very kindly given the author a slide he made many years ago of some parasites from a mouse which includes two more of these spurred nymphs. Their chætotaxy corresponds exactly with that of the specimen in Fig. 9, so it is unlikely that these features are the result of any deformity, and the nymph is probably that of some totally different species.

Feeding Habits

The larvæ and nymphs of *Myobia* are found deep down among the fur of the head of the host, intimately associated with the hair follicles. Several specimens have been obtained by pulling out the hair to which they were attached, in which the proboscis was seen to be deeply inserted into the follicle, presumably feeding on the sebaceous gland. Adult *Myobia* and also *Myocoptes* have been observed with the mouthparts closely applied to the skin of the host, but no special connection with the hair follicles has been noticed, nor could the degree of penetration, if any, be observed. An interesting feature was sometimes noticed in very heavy infestations with *Mycoptes*. Many of the hairs of the host were encircled with a number of small, ring-like structures, sometimes as many as six, piled up above the base of the hair. Examination showed that these were clasping organs of dead *Myocoptes* which, owing to their heavy chitinisation, had persisted long after the rest of the parasite had decomposed and disintegrated.

Pathogenicity

Authors have been divided on the subject as to whether these fur-frequenting mites are of any pathogenic significance. Boccia (1942), in the most recent paper on the subject, reviews the question, and admits that the majority of authors consider the parasites to be quite harmless, but himself holds the opposite view, viz., that they are definitely pathogenic. In view of his own observations, the present author holds that they must not be considered as pathogenic when occurring in reasonable numbers on otherwise healthy animals, but that on a debilitated animal, *Myocoptes* can multiply to an extent where symptoms may be set up, either by direct damage to the skin by the parasite or by irritating the host so that the skin is damaged by violent scratching. *Myobia* multiplies less rapidly, and has not been observed by the author to cause any symptoms.

Previous Literature

Myobia musculi was first mistaken for a louse and described by Schranck (1781) as *Pediculus muris musculi*. It was recognised as a mite by v. Heyden

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(1826), who set up the genus *Myobia* for it. Claparéde (1868) described the egg and the larva. Trouessart (1895) described the nymph and its metamorphosis (from a related species parasitic on a bat). Various papers describe the different species of *Myobia*—Poppe (1896), Radford (1934), Ewing (1938), and Womersley (1942). *Myocoptes musculinus* was described by Koch (1840) as *Sarcoptes musculinus*. General works consulted were "Das Tierwelt Mitteleuropas" and Canestrini's "Prospetto dell' Acarofauna Italiana" (1886).

Summary

Two fur-frequenting parasites of the mouse, *Myocoptes* and *Myobia*, are described and figured in both the adult and immature stages. *Myocoptes* is capable of setting up symptoms of mange in the laboratory white mouse when the normal host-parasite relation is upset. The previous literature is reviewed.

Acknowledgments

The author wishes to thank Mr. R. J. Roe, O.B.E., M.R.C.V.S., D.V.S.M., Chief Veterinary Officer, Cyprus, for permission to publish this paper; Mr. C. D. Radford and Mr. E. Browning, of the British Museum (Natural History), for allowing him to examine specimens of various species in the National Collection, and for helpful advice; and Dr. E. L. Taylor, of Weybridge, for supplying some slides from his own collection.

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OBSERVATIONS ON THE SURVIVAL ON PASTURE OF PREPARASITIC STAGES OF *DICTYOCAULUS VIVIPARUS* IN SOUTHERN ENGLAND.—II

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In the previous report it was shown that susceptible Shorthorn yearlings failed to contract lungworm infection when put on a pasture on October 25, 1950, which had been grazed two months previously by heavily-infected cattle.

The purpose of this study is to record observations on the duration and percentage rate of survival of the free-living stages of the parasites *Dictyocaulus filaria* and *D. viviparus* on outdoor grass plots. A series of experiments were designed for this purpose during the summer of 1951.

Material and Methods

Six wooden boxes were used, each 49 inches square by 6 inches deep. Each was divided by zinc division boards into 49 sections approximately 7 inches square (Fig. 1). The boxes were then arranged out of doors on a relatively protected site. They were placed on brick pillars whose bases were submerged in a disinfectant solution in a shallow concrete bath. By this means insects or migrating, free nematode larvæ were excluded from the boxes. The boxes were then filled uniformly to within 2 inches from the top with a dark brown, loamy soil, procured from the immediate surroundings. The soil was sterilised in the autoclave at 120° C. and 20 pounds pressure to the square inch for two hours before being filled into the boxes. Each of the six boxes was then sown with one ounce of seeds and watered with a very fine spray. This was done on June 6, 1951, the following varieties of seeds being used:—

(1) Red clover; (2) sheep's parsley; (3) spinach; (4) lucerne; (5) timothy; (6) marrow.

The experiment commenced three months later when the growth in different compartments varied from 4 to 6 inches high.

The following materials were used in the different boxes:—

1. Fæces with known larval count from cattle naturally infected with *Dictyocaulus viviparus* and pellets of known larval count from sheep infected with *Dictyocaulus filaria.*

2. First-stage larvæ of both species collected by Baermann's method.

3. Third-stage larvæ of both species. This was secured by collecting larvæ of both species as in (2), and exposing to aeration for six days by bubbling air

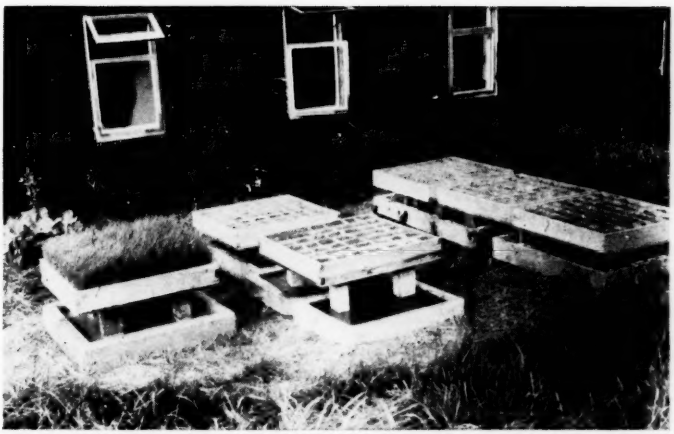

FIG. 1
Showing the set of the designed grass plots as described.

(*Article by Soliman, page* 204).

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through the water in which they were contained, to ensure their development to the infective stage.

The infective material in each case was placed in the centre of a square after watering or after rain, and when the soil was just wet and with no superfluous water on it. After the material was applied, a rinse of 30 c.c. of water was given to ensure against loss of material.

Examination for larvæ was carried out by clipping the grass close to the surface of the soil with a pair of curved scissors. A further sample was collected by scraping the soil surface. Grass samples were soaked in water for 12 hours and then squeezed dry and re-examined by Baermann's technique, allowing the grass to stand in the funnels for 24 hours. If the sample proved to be positive the grass was left for another 24 hours in the Baermann funnel.

The washings were allowed to sediment for 12 hours in round-bottom measuring jars. The supernatant fluid was then decanted and the residue examined under a dissecting microscope.

The soil scrapings were placed in Baermann's apparatus for 48 hours and the lower 60 c.c. drawn off and examined for the presence of larvæ.

Weather Data

The survival and development of infective larvæ of Dictyocaulus species, both in cattle and sheep, depends to a large degree on meteorological conditions. The first-stage larvæ are susceptible to the effects of frost and dryness, and the second- and third-stage larvæ may be affected by drying. For this reason the air temperature was recorded by means of a U-type maximum-minimum thermometer fixed to the side of one of the boxes. Thermometer readings were taken daily and mean results recorded for each seven days during which samples were collected. Meteorological data were collected from the Horticultural Station of the University of Reading, a mile away from the site of the experiment. The readings are recorded in Table I.

TABLE I

Summary of weather data collected at Reading (Horticulture Station of Reading University) during the three months of the experiment.

Month of the year	Temperature			Precipitations		Hours sunshine	
	Mean	Max.	Min.	Total in inches	Snowfall	Monthly average	Daily average
August, 1951 ...	60	68	52	3.80	—	161.0	5.1
September ...	59	66	52	2.83	—	88.8	2.8
October ...	47	56	38	0.85	—	88.2	2.8

As it was important in the first instance to assess the percentage loss

inevitably associated with the technique of collection, a check test was carried out. During the actual experiment, individual squares were examined at weekly intervals.

Experiment I

The material selected for this experiment comprised a sample of bovine fæces containing a total of 2,000 *Dictyocaulus viviparus* larvæ per gram of fæces and one of sheep fæces containing 1,500 larvæ per gram. No other nematode larvæ were present to complicate the picture. As the species in the two animals can be differentiated morphologically it was considered convenient to mix the fæces. Accordingly, three grams of cattle fæces and four grams of sheep pellets representing 6,000 larvæ of each species were mixed together with 30 c.c. of water and put in the middle of each of fourteen squares of each of the six boxes. The container was swilled out with 30 c.c. of water to ensure that no material was left behind. The results recorded from this experiment are presented in Table II.

Column one across, indicating the percentage recovery after 6 hours, provided a test of the efficiency of the technique employed and a figure of the percentage loss to be expected. In the case of *Dictyocaulus viviparus* larvæ the mean recovery from all the different grasses together after 6 hours was 20.83 per cent; the lowest percentage of recovery was 19 from spinach and the highest was 22 from both sheep's parsley and lucerne. In the case of *Dictyocaulus filaria* the mean percentage was 23.8; the lowest percentage of recovery was 21 from timothy, and the highest 30 from sheep's parsley.

There is a difference of 3 per cent between the two mean percentage recovery rates for the two species. This may be explained on grounds of the difference in the size of the two larval species, *Dictyocaulus filaria* being the larger, and thus its chances of escaping in the interstices of the soil were less than in the case of *Dictyocaulus viviparus* larvæ.

The difference between the mean recovery rate of the two species from eight plots of parsley and eight plots of spinach was greater than from the other plots. This may perhaps be explained by the fact that the herbage was not growing so closely and the soil was showing between the individual plants. Furthermore, where the soil surface was greatest the "washing-in" effect of the rain would be more pronounced. During the 24 hours prior to the first collection the rainfall amounted to 0.29 inches.

After seven days' exposure to outdoor conditions, the percentage of recovery from the six different plots of plants for both species of larvæ ranged from 1.2 to 2, with a mean figure of 1.63 per cent. The figures from the different plant squares in each case of *Dictyocaulus filaria* was still higher as a whole than those for *Dictyocaulus viviparus*, and the mean for both was 1.78 per cent and 1.48 per cent, respectively.

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After a fortnight the percentage of recovery fell below 1 per cent except in the case of *Dictyocaulus filaria* from red clover, which was 1.1 per cent. Again, the same difference existed between the two mean figures for both species, being 0.6 per cent for *Dictyocaulus filaria* and 0.33 per cent for *Dictyocaulus viviparus*. After three weeks, the lucerne and marrow plots were totally negative for both larvæ. The timothy figures were equal. In both sheep's parsley and spinach only *Dictyocaulus filaria* larvæ were in existence, and from red clover the figure for *Dictyocaulus filaria* was three times higher than that for *Dictyocaulus viviparus*. This could be explained by the higher powers of migration of *Dictyocaulus filaria*, giving them more chance of getting away out of the soil conditions and bacterial contamination.

After four weeks' time up to seven weeks the whole plots were totally negative for the presence of both larvæ.

Experiment II

In this experiment the material used was first-stage larvæ of both species isolated from fæces by Baermann's method. The larvæ were in tap water and were therefore in an environment relatively free from bacteria as compared with the first experiment. Eight small grass squares of each of the six different kinds of herbage were individually inoculated with 3,000 of each of the two species. The inoculum was applied to the middle part of the soil surface of each plot. After applying the material, the containers were washed out with 30 c.c. of tap water to ensure against loss of material. Details of duration of survival and rate of recovery are recorded in Table III.

Column one across, indicating the percentage recovery after 6 hours, provided a test of the efficiency of the technique employed and also provided a figure of the percentage loss to be expected. The mean percentage recovery of *Dictyocaulus viviparus* larvæ from the six different plant plots after 6 hours was 16.6; the lowest percentage of recovery was 15 from marrow, and the highest was 18 from red clover. In the case of *Dictyocaulus filaria* the mean percentage of recovery after the same period was 18.96; the lowest was 18 from the three kinds of grass (lucerne, timothy and marrow), and the highest was 20 from both kinds of plants (red clover and sheep's parsley).

In this experiment, as in Experiment I, the mean percentage of recovery of *Dictyocaulus filaria* larvæ was higher than that for *Dictyocaulus viviparus*. There was a difference of 2.36 between the two mean percentage recovery figures for the two species. The same explanation given before may be the influencing factor here also.

The figures representing the mean percentage recovery for both species in this experiment are much less than those in the first experiment. Using the first-stage larvæ of *Dictyocaulus viviparus* in tap water, the mean percentage recovery after 6 hours was less by 4.23 than in the first experiment, and in

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TABL II

Recovery of infective larvæ of *Dictyocaulus viviparus* and *Dictyocaulus fila* under
on gra plots.
First-stage larv in fæ

Date of inoculation	Date of collection	Time of exposure (days)	Mean max. temp.	Rainfall (in.)	No. of larvæ inoculated per square	Red clo D.V.
5.8.51 ...	5.8.51	¼	73	0.29	6,000 *D.V.*	21
	11.8.51	7	70	1.97	+	1.2
	18.8.51	14	67	0.28	6.000 *D.F.*	0.3
	25.8.51	21	53	0.25		0.1
	1.9.51	28	64	1.63		—
	8.9.51	35	68	0.42		—
	15.9.51	42	68	0.18		—
	22.9.51	49	62	0.21		—

Rainfall figures represent total for seven days' period. D.V. =

TABL III

Recovery of infective larvæ of *Dictyocaulus viviparus* and *Dictyocaulus fila* under
on gr plots.
First-stage lar in tap

Date of inoculation	Date of collection	Time of exposure (days)	Mean max. temp.	Rainfall (in.)	No. of larvæ inoculated per square	Red clo D.V.
12.9.51 ...	12. 9.51	¼	72	tr.	3.000 *D.V.*	18
	19. 9.51	7	65	0.39	+	2
	26. 9.51	14	64	0.41	3,000 *D.F.*	0.1
	3.10.51	21	63	1.30		—
	10.10.51	28	60	tr.		—
	17.10.51	35	60	0.08		—
	24.10.51	42	54	0.12		—
	31.10.51	49	55	0.30		—

Rainfall figures represent total for seven days' period. D.V. =

TABL IV

Recovery of infective larvæ of *Dictyocaulus viviparus* and *Dictyocaulus fila* under
on gra plots.
Third-stage lar develo

Date of inoculation	Date of collection	Time of exposure (days)	Mean max. temp.	Rainfall (in.)	No. of larvæ inoculated per square	Red clo D.V.
19.9.51 ...	19. 9.51	¼	59	—	3,000 *D.V.*	19
	26. 9.51	7	64	0.41	and	2.1
	3.10.51	14	63	1.30	3,000 *D.F.*	1.8
	10.10.51	21	60	tr.	in separate	0.6
	17.10.51	28	60	0.08	squares	0.1
	24.10.51	35	54	0.12	each	—
	31.10.51	42	55	0.30		—

Rainfall figures represent total for seven days' period. D.V. =

TABLE II

under certain conditions of temperature and moisture after outdoor exposure plots.

in fæcal material.

Red clover		Sheep's parsley		Percentage recovery of larvæ Spinach		Lucerne		Timothy		Marrow	
D.V.	*D.F.*	*D.V.*	*D.F.*	*D.V.*	*D.F.*	*D.V.*	*D.F.*	*D.V.*	*D.F.*	*D.V.*	*D.F.*
21	23	22	30	19	24	22	23	20	22	20	22
1.2	2	1.5	1.9	1.8	1.6	1.7	1.8	1.5	1.4	1.2	2
0.3	1.1	0.7	0.6	0.2	0.3	0.1	0.8	0.5	0.4	0.2	0.4
0.1	0.3	—	0.1	—	0.1	—	—	0.2	0.2	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—

D.V. = *Dictyocaulus viviparus.* *D.F.* = *Dictyocaulus filaria.*

TABLE III

under certain conditions of temperature and moisture after outdoor exposure plots.

in tap water.

Red clover		Sheep's parsley		Percentage recovery of larvæ Spinach		Lucerne		Timothy		Marrow	
D.V.	*D.F.*	*D.V.*	*D.F.*	*D.V.*	*D.F.*	*D.V.*	*D.F.*	*D.V.*	*D.F.*	*D.V.*	*D.F.*
18	20	17	20	17	19	17	18	16	18	15	18
2	3.1	1.8	2	1.9	2.1	1.5	2.2	1.2	2	2.1	2.5
0.1	1.5	0.1	0.8	0.2	0.3	0.1	0.2	0.1	0.4	0.1	0.5
—	0.2	—	0.1	—	—	—	—	0.1	0.1	—	0.3
—	0.1	—	—	—	—	—	0.1	—	—	—	0.1
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—

D.V. = *Dictyocaulus viviparus.* *D.F.* = *Dictyocaulus filaria.*

TABLE IV

under certain conditions of temperature and moisture after outdoor exposure plots.

developed experimentally.

Red clover		Sheep's parsley		Percentage recovery of larvæ Spinach		Lucerne		Timothy		Marrow	
D.V.	*D.F.*	*D.V.*	*D.F.*	*D.V.*	*D.F.*	*D.V.*	*D.F.*	*D.V.*	*D.F.*	*D.V.*	*D.F.*
19	20	18	21	19	22	19	21	17	19	16	20
2.1	3.5	2	3.4	2.3	4.1	2.1	2.4	1.9	2.2	2.5	3.1
1.8	2.1	1.1	2.2	1.2	2.8	0.8	1.1	0.9	1.0	0.9	2.0
0.6	0.8	—	0.3	0.1	0.8	0.5	0.6	0.1	0.3	0.1	1.3
0.1	1.1	—	0.1	—	0.3	0.1	0.1	—	0.1	—	0.1
—	0.1	—	—	—	0.1	—	—	—	—	—	0.1
—	—	—	—	—	—	—	—	—	—	—	—

D.V. = *Dictyocaulus viviparus.* *D.F.* = *Dictyocaulus filaria.*

Dictyocaulus filaria it was less by 4.84. This may be expected on grounds of the difference in the media that contained the material used. In the first experiment the larvæ were in fæcal material; while, in the second, larvæ were in tap water. Thus, in the first case the larvæ stood less chance of escaping through the interstices of the soil particles.

After seven days' exposure to outdoor conditions, the percentage of recovery from the six different plots of plants for both species of larvæ ranged from 1.2 to 3.1, with a mean figure of 2.33. The figures from the different plants in the case of *Dictyocaulus filaria* were still higher as a whole than those for *Dictyocaulus viviparus*, and the mean for both were 2.31 and 1.75, respectively. These figures are somewhat higher than those in the first experiment; this may have been caused by the death rate during development to the final stages being lower in the second experiment as the applied larvæ were in tap water.

After a fortnight, the percentage recovery fell again beyond 1 except in the case of *Dictyocaulus filaria* from red clover, which was 1.5. Again, the same difference appeared between the two mean figures for both species, being 0.61 for *Dictyocaulus filaria* and 0.11 for *Dictyocaulus viviparus*. After three weeks, the spinach and lucerne plots were totally negative for both larvæ. The timothy figures were equal. *Dictyocaulus filaria* only was found in red clover, sheep's parsley and marrow.

After four weeks, 0.1 per cent recovery of *Dictyocaulus filaria* was found from the red clover, lucerne and marrow plots.

After five weeks up to seven weeks, all the plots were negative for the presence of both species.

Experiment III

In this experiment the material was third-stage larvæ of both species. The inoculum of 3,000 larvæ was applied to the squares in the same way previously described. Each of the two species of larvæ was applied separately in special squares, seven small squares being used for each one of them. The summary of survival and rate of recovery are recorded in Table IV.

In this experiment the material used was the infective-stage larvæ of both species in tap water. The mean percentage recovery of *Dictyocaulus viviparus* larvæ from the six different plant plots after 6 hours' exposure was 18; the lowest percentage of recovery was 16 from the marrow, and the highest was 19 from both the red clover and the spinach. In the case of *Dictyocaulus filaria* the mean percentage was 20.5; the lowest percentage of recovery was 19 from timothy, and the highest 22 from spinach.

In this third experiment there was still a difference of 2.5 between the two mean percentage recoveries for the two species. The same possible explana-

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tion previously given for such differences in the first two experiments may have been the influencing factor.

After seven days' exposure to outdoor conditions, the percentage of recovery from the six different plots of plants for both species of larvæ ranged from 1.9 to 4.1, with a mean figure of 2.63. The figures from the different plant plots in the case of *Dictyocaulus filaria* were still higher as a whole than those for *Dictyocaulus viviparus*, and the mean for both was 3.11 and 2.15, respectively.

After a fortnight, the percentage of recovery in general for both species was above 1 except in three instances of *Dictyocaulus viviparus* from plots of lucerne, timothy and marrow, where it was 0.8, 0.9 and 0.9, respectively. Again, the same difference between the two mean figures for both species was found, being 1.81 for *Dictyocaulus filaria* and 1.16 for *Dictyocaulus viviparus*.

It was only after three weeks in this experiment that the percentage of recovery fell below 1.0. The difference between the two figures for both species was still present. Only from one plot—the sheep's parsley plot—could no larvæ be recovered.

After four weeks, *Dictyocaulus viviparus* could only be recovered from two plots—red clover and lucerne—while *Dictyocaulus filaria* was recovered in very low percentages from all the six different plant plots.

After five weeks, only *Dictyocaulus filaria* was recovered from the three plots, red clover, spinach and marrow.

After six weeks, no larvæ were recovered from any of the experimental plots of different plants.

A striking feature in this last experiment was that the duration of survival was longer by two weeks than that of the first experiment and by one week than the second. This fact is to be expected, as the material used in Experiment III was the most resistant form of the three pre-parasitic stages of both species.

Discussion

This work was carried out in 1951 and is a continuation of earlier investigations. The results confirm the earlier work and support the views expressed by Porter, *et al.*, in 1941, and the same author in 1942, on the survival time of the larvæ of *Dictyocaulus viviparus* in its pre-parasitic phase.

In the first two experiments—in which the material contained first-stage larvæ, representing the least resistant phase—the percentage of recovery fell below 1 after the first fortnight in both species. When fæcal material was used, which represents a high degree of bacterial contamination, the recovery rate was appreciably less than when the one larvæ were used as experimental material. Presumably, therefore, bacterial contamination plays some part in lowering

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survival rate. When the third- or infective-stage larvæ were used, the recovery rate at the end of a fortnight was somewhat more than 1 per cent, some larvæ of the sheep lungworm being recovered at the 35th day. No larvæ of the cattle lungworm were, however, recovered after the 28th day.

In each of the three experiments, the mean percentage recovery rate was always somewhat greater with *Dictyocaulus filaria* larvæ. It is perhaps worth while speculating on the factors which influence the recovery rate. Whilst the size of *D. filaria* is larger than that of *D. viviparus* in the third stages, the migratory vigour of *D. filaria* is known to be greater than that of *D. viviparus*. These two factors may account for the high percentage of recovery of *D. filaria* in the series of experiments. The relatively small size of *D. viviparus* may result in its being washed deeper into the interstices of the soil. In view of the loss of material and the error in recovery in such experiments, it might be assumed that the figures recorded are the minimum estimations of the survival of these two species of larvæ out of doors.

Observations on the different types of herbage revealed a higher percentage of recovery and the time of survival longer in those cases where plants provided adequate shelter—namely, red clover, lucerne and marrow. The longer survival time here also may be explained by the known greater ability of *Dictyocaulus filaria* to migrate upwards, whilst *Dictyocaulus viviparus* is a poor climber.

Summary

1. Infective material containing the first-stage larvæ of both *Dictyocaulus filaria* and *Dictyocaulus viviparus* in (*a*) fæces and (*b*) tap water were exposed out of doors on miniature plots with six different types of grass, during the later part of the summer season of 1951. The plots were examined at weekly intervals.

2. With the first-stage larvæ, percentage recovery fell below 1 after a fortnight. With the third-stage larvæ, the percentage of recovery fell below this level after three weeks.

3. Using third- or infective-stage larvæ, no *Dictyocaulus filaria* were recovered after 35 days' exposure and no *Dictyocaulus viviparus* after 28 days.

4. Owing to possible loss of material inevitably associated with the technique employed, the recovery figures recorded can only be regarded as a minimum estimation of the survival rate of these two larvæ under the conditions of the exposure.

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STUDIES IN BOVINE MALIGNANT CATARRH.—II

Experimental Infection of Cattle (Continued)

(i) Infectivity of Materials Other than Lymph Gland
(ii) Routes of Inoculation

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In a previous article (Piercy, 1952), the successful transmission of a virulent strain of the "head-and-eye" form of malignant catarrh through nineteen generations in cattle by gland-to-gland inoculation was described. Whilst this proved an effective method of transmission, neither the material nor the route of inoculation used could be considered ideal. Lymph gland, although rich in virus, compares unfavourably with, for example, blood or spleen in the ease with which it can be prepared for sub-inoculation, whilst the intraglandular technique necessitates considerable manual assistance if the inoculum is to be deposited with certainty into the gland of choice. Attention was directed, therefore, to the infectivity of other materials and to alternative routes of inoculation, both to obtain knowledge of the location of virus in bovine tissues, and to establish a simpler method of routine transmission.

Most workers have used either blood, gland, or brain in attempts to transmit malignant catarrh. Results have been variable. Whereas Mettam (1923), Götze and Liess (1929), Rinjard (1935), Magnusson (1940), and Daubney and Hudson (1936) were all able to transmit the disease with blood, Dobberstein and Hemmert-Halswick (1928), Stolnikof (1933), and de Kock and Neitz (1950) were unsuccessful. In this connection, Piercy (1952) has drawn attention to the relative ease with which one strain ("D") of malignant catarrh was transmitted to cattle whilst another (Ngong), although isolated from an extremely similar type of outbreak, proved refractory.

The virus of malignant catarrh is extremely fragile, and it seems likely that the success or failure of initial transmission experiments is governed not only by the strain concerned, but also by the length of time permitted to elapse between the collection of material and its inoculation into susceptible animals. When blood is used, the quantity inoculated seems to be an important point and nearly all successful transmissions have been achieved using large amounts, up to 500 c.c. (cf. Mettam, 1923; Rinjard, 1935; Daubney and Hudson, 1936).

In view of the fact that 1 to 2 c.c. of infective gland suspension will transmit with regularity, it would seem that the content of virus in blood is comparatively low. Mettam (1923) considered that circulating virus is attached to erythrocytes, but evidence will be presented later in this article indicating that the lymphocyte

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may be the host cell. This would explain the need for the use of such massive doses of blood.

Reference to the use of materials other than blood, brain, and gland is scarce. In this article, transmission experiments with gland, blood, spleen, liver, and adrenal gland are described. Since it was thought that the success of needle transmission might also be qualified by the route of inoculation, certain experiments were designed to elucidate this point.

Materials and Methods

(i) *Blood.*—In the early experiments, blood was collected aseptically into O.C.G. preservative, consisting of 500 c.c. of glycerine, 500 c.c. of distilled water, 5 gm. of potassium oxalate, and 5 gm. of carbolic acid. Most animal viruses — for example, rinderpest, Rift Valley fever, bluetongue, and African horsesickness — keep well in this medium and it was anticipated that it would prove equally suitable for the virus of malignant catarrh. This proved not to be the case and, in later experiments, blood was collected into a saturated solution of sodium citrate in the proportion of 6.3 c.c. of citrate to 100 c.c. of blood.

(ii) *Liver, spleen, and adrenal gland.*—These materials were removed aseptically from reacting animals immediately after destruction and ground up with the aid of a mortar and pestle, sterile sand, and broth. The suspensions, which contained about 20 per cent of the tissue concerned, were allowed to sediment by gravity and the thick supernatant fluids drawn up into a syringe through a wide-bored needle. They were not centrifuged since it was known that the virus of malignant catarrh, being attached to cells, is rapidly thrown down by this means, leaving the supernatant fluid relatively non-infective.

All inoculations were made within a few hours of harvesting. The donors were animals which had been showing typical symptoms of malignant catarrh for four to five days. All glandular inoculations were made into the prescapular lymph gland.

(iii) *Virus strain.*—The "D" strain (Piercy, 1952) was used throughout.

(iv) *Challenges.*—These consisted of the intraglandular inoculation of 1 to 2 c.c. of a 20 per cent suspension of known infective lymph gland.

(v) *Cattle.*—The animals used were generally young low-grade steers immune to rinderpest. Occasionally Zebu, Boran, and pure-bred exotic breeds were used since it had become obvious during the earlier work that neither breed nor age qualified susceptibility.

(vi) *Separation of blood elements.*—Four hundred c.c. of citrated blood was distributed into centrifuge tubes and spun at 2,000 r.p.m. for ten minutes. The main bulk of the plasma was removed and set aside for subsequent inoculation. The middle portions of each column of blood, consisting of the remaining plasma, the buffy coat, and a small amount of the underlying red

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cells, were removed from each tube, pooled, and recentrifuged. After this process had been repeated twice, about 2 c.c. of cells containing a high proportion of leucocytes remained. An equal volume of normal saline was added, the mixture shaken, and again centrifuged. After discarding the supernatant fluid, a mixture remained, the top half of which had the appearance of a thick, white cream. This layer was again removed, shaken up with saline, placed in a narrow tube measuring 100 mm. by 5 mm., and centrifuged at 5,000 r.p.m. for fifteen minutes. After pouring off the supernatant saline, the tube was broken just above the column of cells and about 0.05 c.c. of the thick white layer drawn up into a syringe through a wide-bored needle. One c.c. of saline was added, and this constituted the concentrated white cell inoculum.

Ten c.c. of red cells, from which the plasma and buffy coat had been removed as described above, were centrifuged again and the top half discarded. An equal portion of normal saline was added and the mixture spun in a tightly-corked centrifuge tube placed upside down in the centrifuge. After spinning at 5,000 r.p.m. for fifteen minutes, the cork was carefully withdrawn and the lower half of the red cells collected into another tube. After this process had been repeated twice, these cells constituted the red cell inoculum.

Results

Table I summarises the following transmission experiments.

Infectivity of Materials

(i) *Blood in O.C.G.*—Bovines 9601 and 141 each received 2 c.c. and bovine 771 10 c.c. of blood by intraglandular inoculation. Of the first two, one reacted and died after a prolonged incubation period of forty-three days; the other failed to react but when challenged proved to be immune. The third animal (771) showed slight lachrymation from both eyes during the fourth week after inoculation, although its temperature remained normal. Seven weeks after inoculation a marked rise in temperature occurred, lasting for three days and reaching a peak of 106.0° C. No other symptoms were observed, and when challenged sixty days after inoculation this animal also proved to be immune.

Bovine 359 was given 7 c.c. and bovine 206 10 c.c. of blood intravenously. The former did not react. The latter went through a mild reaction, commencing on the thirty-first day after inoculation, and characterised by a temperature rise to about 104.0° C. for two days, slight ocular and nasal discharges, and a faint corneal opacity of the left eye. When challenged, both these animals were found to be immune.

(ii) *Blood in citrate solution.*—Bovine 1755 given 10 c.c. and bovines 1901 and 1990 given 1 c.c. of blood intravenously. All reacted and died of malignant catarrh.

(iii) *Spleen.*—A Jersey calf given 2 c.c. of spleen by intraglandular inoculation reacted twenty-five days later and died of malignant catarrh.

Bovines 1818, 1808, and 1711, given 10 c.c., 3 c.c., and 1 c.c. respectively of spleen intravenously, all died of malignant catarrh within the usual period.

(iv) *Liver.*—Bovine 1214, given 2 c.c. of liver by intraglandular inoculation, reacted nineteen days later and died of malignant catarrh.

Bovine 1218, given 5 c.c. of liver intravenously, died of malignant catarrh after a prolonged incubation period of fifty-one days.

(v) *Adrenal gland.*—Bovine 1217, given 2 c.c. of adrenal gland by intraglandular inoculation, appeared to go through a very mild reaction commencing on the twentieth day, but when challenged ten weeks after inoculation it reacted and died.

Bovine 1215, given 5 c.c. of adrenal gland intravenously, died suddenly thirty-eight days later. When seen, the carcass was highly decomposed, precluding the recognition of specific lesions.

(vi) *An examination of blood elements.*—Citrated blood obtained from bovine 1990 was divided into its component parts by the procedure described under the section headed "Technique." Stained smears showed an occasional indefinite basophilic body amongst the red cells, and a very occasional red cell amongst the white cell inoculum. The plasma was cell free. The following intravenous inoculations were carried out:—

Bovine 1978 received 4 c.c. of whole blood, bovine 2204 3 c.c. of plasma, bovine 2194 1 c.c. of red cells, and bovine 2174 0.05 c.c. of concentrated white cells suspended in 1 c.c. of saline. These inoculations were made some six hours after the blood was drawn. Bovine 1978, receiving whole blood, died of malignant catarrh. None of the other three animals reacted, and when challenged two months later they proved to be susceptible.

Using citrated blood from bovine 2061, the above experiment was repeated and the following cattle inoculated by the intraglandular route. Bovine 2170 received 6 c.c. of plasma, bovine 1973 0.05 c.c. of concentrated white cells suspended in 1 c.c. of saline, and bovine 2169 4 c.c. of red cells. Stained smears and hæmocytometer counts revealed that the separation of blood elements was less complete than in the previous trial; in fact, the number of leucocytes in the red cell inoculum approached the lower limit of normality. In the white cell inoculum, however, the proportion of leucocytes to erythrocytes had been increased to about 1 : 5, as compared with the normal figure of about 1 : 750. The plasma was cell free.

Bovine 2170, receiving plasma, did not react and was later shown to be susceptible. Both the other two animals reacted and died of malignant catarrh within the usual period.

Routes of Inoculation

Experiments using the intraglandular and intravenous routes have been

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described in the preceding section and will be discussed in more detail later. The following additional routes of inoculation were examined.

(i) *Subcutaneous.*—Bovine 2329 given 6 c.c. of spleen, and bovines 2229, 2582, 2578, and 2613 given 10 c.c., 5 c.c., 4 c.c., and 3 c.c. respectively of gland, all died of malignant catarrh.

(ii) *Intramuscular.*—Bovine 2317, given 5 c.c. of lymph gland, reacted after a short incubation period of fourteen days and died of malignant catarrh.

(iii) *Intradermal.*—Bovine 1827, given 0.5 c.c. of spleen suspension, commenced to show symptoms of an ocular discharge thirty-three days later. For the next ten days a slight and very irregular temperature reaction occurred, accompanied by ocular and nasal discharges of gradually increasing severity and some hyperplasia of superficial lymph glands. Thirteen days after clinical symptoms were first seen, a slowly ascending temperature elevation occurred over the next five days, after which the animal was destroyed on humane grounds. It is a remarkable fact that during the whole clinical syndrome of eighteen days this animal retained its appetite and remained lively.

TABLE I

TRANSMISSION OF BOVINE MALIGNANT CATARRH

Material	*Route*	*Animal*	*Inoculum* c.c.	*Result*	*Challenge*
Blood in O.C.G.	i/g	9601	2.0	Died of malignant catarrh. Incubation period 43 days.	—
"	"	141	2.0	No reaction.	Immune
"	"	771	10.0	Mild reaction, recovered.	"
"	i/v	359	7.0	No reaction.	"
"	"	206	10.0	Mild reaction, recovered.	"
Blood in citrate	"	1755	10.0	Died of malignant catarrh.	—
"	"	1901	1.0	"	—
"	"	1990	1.0	"	—
"	"	1978	4.0	"	—
Spleen	i/g	Jersey calf	2.0	"	—
"	i/v	1818	10.0	"	—
"	"	1808	3.0	"	—
"	"	1711	1.0	"	—
"	i/d	1827	0.5	"	—
"	s/c	2329	6.0	"	—
Liver	i/g	1214	2.0	"	—
"	i/v	1218	5.0	Died of malignant catarrh. Incubation period 51 days.	—
Adrenal gland ...	i/g	1217	2.0	Mild reaction?	Susceptible
" ...	i/v	1215	5.0	Died, other causes.	—
Lymph gland ...	i/m	2317	5.0	Died of malignant catarrh.	—
" ...	s/c	2229	10.0	"	—
" ...	"	2582	5.0	"	—
" ...	"	2578	4.0	"	—
" ...	"	2613	3.0	"	—
Plasma	i/v	2204	3.0	No reaction.	Susceptible
Red cells ...	"	2194	1.0	"	"
White cells ...	"	2174	0.05	"	"
Plasma	i/g	2170	6.0	"	"
Red cells ...	"	2169	4.0	Died of malignant catarrh.	—
White cells ...	"	1973	0.05	"	—

Note: i/g = intraglandular, i/v = intravenous, i/d = intradermal, s/c = subcutaneous, i/m = intramuscular.

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Discussion

The transmission experiments with whole blood revealed marked differences in the infectivity of blood in O.C.G. and blood in citrate solution. Of the five animals which received the former, one reacted and died after a prolonged incubation period; the others reacted very mildly or not at all but were later shown to be immune. Citrated blood, however, caused fatal reactions in all cases. It is evident, therefore, that O.C.G. solution is unsuitable for the preservation of malignant catarrh virus. Presumably this is due to the presence of phenol, since Daubney and Hudson (1936) have shown that the virus will remain alive in 50 per cent glycerine, the other active constituent of O.C.G., for periods up to seven days. It may well be that those animals which survived inoculation with blood in O.C.G. and gained immunity, received virus which was dead or reduced to very low potency, and that the effect was one simulating vaccination. It may be added that successful transmission experiments, using blood, performed by other workers (Mettam, 1923; Götze and Liess, 1929; Daubney and Hudson, 1936) were accomplished with oxalated or defibrinated blood.

Transmission of malignant catarrh with citrated blood, spleen, and gland emulsions was always successful. When materials whose virus content was lower were used, there was some evidence that infection is more likely to be established by the intraglandular rather than the intravenous route. For example, the only animal out of five to react fatally to blood in O.C.G. preservative was bovine 9601, inoculated into the gland. Of the animals receiving liver emulsion, bovine 1214, inoculated into the gland, reacted on the eighteenth day and died within the normal period, whereas the other (1218), inoculated intravenously, did not react until the fifty-first day. In the first passage with the "D" strain (Piercy, 1952), transmission was effected by the intraglandular route but not by the intravenous route. When attempts were made to separate the blood elements, none of the animals inoculated intravenously reacted, whereas intraglandular inoculations produced successful results with both the red and white cell inocula. If the suggestion already made (Piercy, 1952), that the predilection site for the virus of bovine malignant catarrh is lymphatic tissue, is correct, it follows that materials low in virus content are more likely to cause infection if deposited directly into a gland than if inoculated into the blood stream.

A point of interest is the failure to transmit malignant catarrh with adrenal gland. Histo-pathological examinations of this gland have constantly revealed typical lesions, characterised by accumulations of proliferating lymphatic and lymphopoietic elements. Since only two animals were involved, one of which died from causes unknown, undue emphasis on this point is unwarranted.

Attempts to examine the chief components of infective blood met with only partial success, chiefly due to the difficulty of separating the red and white cells. The lengthy procedure used, during which the material was exposed to room temperature, may well have resulted in death of the virus and the negative results of the first transmission experiment. Failure to infect with

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plasma was expected since Mettam (1923) had already demonstrated this point. The one fact of great interest is that 0.05 c.c. of concentrated white cells was sufficient to effect transmission. This was an exceedingly small dose compared with the large volumes of blood which other workers have found it necessary to use, and supports the view that the virus is attached to white rather than to red blood cells. Mettam (1923), who stated that the virus is attached to red cells, based his view on the fact that he was able to transmit the disease with washed blood cells but not with cell-free plasma. But this author made no attempt to separate erythrocytes from leucocytes.

A further point of value is that malignant catarrh was transmitted without difficulty with small quantities of gland or spleen by the subcutaneous, intramuscular, and intradermal routes. For these inoculations virus of the later passages (14 to 23) was used. It is evident that the "adaptation" of the "D" strain to needle passage has now reached a stage when the comparatively laborious method of gland-to-gland inoculation need no longer be employed.

Summary

1. Cattle were infected with bovine malignant catarrh, using small quantities of lymph gland, blood, spleen, and liver, but not with adrenal gland.

2. Cattle were infected by the intraglandular, intravenous, intradermal, intramuscular, and subcutaneous routes.

3. One animal was infected with 0.05 c.c. of a concentrated white cell inoculum. It is considered that transmission with this comparatively minute dose suggests that circulating virus is attached to white rather than to red cells.

4. Oxy-carbol-glycerine preservative, commonly used for most animal viruses, was found to be unsuitable for the virus of bovine malignant catarrh.

5. There was evidence that transmission with materials low in virus content is most likely to be successful when the intraglandular route is used.

6. The virus used ("D") has reached a stage in its "adaptation" to needle passage when the subcutaneous inoculation of small quantities of material may safely replace the gland-to-gland technique.

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REVIEWS

LINTON'S ANIMAL NUTRITION AND VETERINARY DIETETICS, by J. T. Abrams. Third Edition, 1950. Edinburgh: W. Green & Son. Price £2 2s.

THE many advances in our knowledge of nutrition, biochemistry and other related sciences has necessitated a very thorough revision of Professor Linton's popular text of 1943. It is to Dr. Abrams' credit that he has succeeded in incorporating the new material, as well as a consideration of certain aspects of nutrition new to " Linton," without increasing the size of the book.

In general the book follows the same format as the two previous editions. Section I deals with the chemical composition and metabolism of the basic constituents of foods. The chapter on vitamins has been brought up to date and the mass of new knowledge which has become available during the last few years has been excellently reviewed. Section II discusses the discriminant foods available for animals, together with their preparation and storage. Section III is new to this edition and has been introduced by the author to link the various food-substances with the differing feeding regimens peculiar to the numerous species of domesticated animals. In this section, following a brief outline of comparative digestive processes, the food requirements for growth, maintenance and production are discussed. Section IV deals with the evaluation of the various foods as biological nutrient materials, the construction of rations and the application of these principles to the practical feeding of animals. In this section Dr. Abrams has increased the usefulness of the textbook by incorporating the available information relevant to feeding the other small domesticated carnivora as well as the dog. Suggested diets and rules for feeding various laboratory animals should prove very useful for the increasing number of establishments concerned with rearing these animals.

The final chapter of Section IV is also new to this edition and serves to introduce the efficiency or economic factor into dietetics. This most important aspect of nutrition, as the author points out, may be the factor which nutritionists, and all those others associated with the animal industry, and indeed the ordinary citizen, may well be concerned with most in the near future.

Few criticisms can be levelled at this book. Perhaps in the section on the feeding of calves, points such as the feeding of milk from artificial teats, the value of colostrum as a conveyor of immune-bodies, the danger of parasitic pneumonitis if the young animals are turned out for exercise, could be suggested as omissions which might possibly have enhanced the value of this section.

A new feature of the book is the introduction of illustrative plates, but unfortunately these have been placed together at the end, consequently losing some of their graphic value. The index has been enlarged and a separate author index has been added. The tables have been brought up to date. The book is bound strongly, laid out well, and printed clearly on good paper.

It is certain that this third edition of Linton's original textbook will continue to serve a wide public and it can be thoroughly recommended, both as a practical guide and a book of reference for veterinarians. Without doubt it will remain a standard manual for veterinary undergraduates and it should serve them well.

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TRATADO DE LAS ENFERMEDADES DEL PIE DEL CABALLO, by Antonio Pires, Professor of Pathological Surgery and Podology, the Veterinary School, National University of Buenos Aires.

WE are under a great obligation to Professor Pires for his work on the diseases of the horse's foot, which is an excellent book in every way and which fills a gap in veterinary literature that has existed far too long. It is not surprising that such a work should have been produced abroad, for with complete mechanisation of agriculture almost a *fait accompli* all over England, and with the horse being increasingly relegated to the riding school, the hunting field and the race-course, it is doubtful if any publisher here could have taken the financial risk of publishing a work dealing exclusively with this subject. On the Continent, in South America, Russia and elsewhere, however, the situation is very different, since for one reason or another mechanisation has not been carried as far as it has here and the horse still plays a vital part in agricultural economy and requires serious consideration on the part of the farrier and veterinary surgeon.

Even with our very limited scope for horse practice it is essential that we have to hand a good reference book on the pathological changes which may take place in the horse's foot. The book serves this purpose. The text is lucid and concise and there are many excellent illustrations.

Each section has an extensive list of references culled from past and present world literature. An English version of the book would widen its scope and be very welcome. R.H.A.M.

ELEMENTS OF ANIMAL NUTRITION, by W. M. Ashton. London: Charles Griffen & Co., Ltd. (1950). 20s. net.

THE nutritional requirements of livestock are likely to command an increasing interest not only in this country but throughout the world. Concurrently with this there will be an ever-growing demand for authoritative textbooks, each aimed at satisfying the needs of a particular section, or sections, of this interest. In this book the author has set out to give the essential foundations of sound animal feeding; and though the book is primarily designed for undergraduate students of agricultural chemistry, it is claimed that this book will be found useful to all those with problems in animal feeding.

The general impression gained from reading the book is one of conciseness with compactness; in just under two hundred pages a wide field is covered in an endeavour to give firstly the basic principles of animal nutrition, and subsequently by rational application of these principles to describe the construction of rations for each of the farm animals.

The general format of the text conforms to the orthodox plan for books dealing with animal nutrition. It commences with chapters on the classification of food constituents including details of their nature and function: stress is laid on chemical structure, and on the chemical processes involved in digestion,

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absorption, and utilisation of the foods by the animal body. Consideration in some detail is given to the foodstuffs commonly used for livestock feeding, the accent here being on the home-grown foods and their satisfactory utilisation by the stock feeder. The feeding standards in common use to-day, namely those based on starch equivalent (Great Britain) and the American and Scandinavian systems, are explained as a preliminary to a general consideration of the formulation of actual rations based on the application of the starch and protein equivalents. Separate chapters are devoted to consideration of the feeding of each of the classes of farm animals. An appendix is given in which data on the composition and nutritive value of the common feeding stuffs are tabulated.

ABSTRACT

THE INTRAPERITONEAL USE OF HEXONAL AS A MEANS OF PRODUCING NARCOSIS IN THE PIG, by M. V. Chernyavski, Bachelor in Veterinary Science, the Moscow Chemico-technical Institute for Meat Production, *Veterinaria,* No. 1, 1952.

AMONG the many indications for narcosis in the pig are the castration of old boars, operations for hernia, prolapse of the rectum, operations on cryptorchids, etc., and there can be no doubt that the usual methods of producing narcosis are open to many objections. Ether and chloroform require the use of special apparatus and skilled assistance, and the anæsthetic doses of these substances are close to the toxic level: the intravenous use of chloral hydrate requires considerable practice. The author strongly recommends the use of hexonal into the peritoneum as being efficient, safe and easy to use, the substance being used in an isotonic sterile 1.5-2 per cent solution in saline in the following doses: For pigs of 30 kg. and over, 0.05 gm. per kilogram bodyweight, while for those under 30 kg. the dose should be 0.05-0.1 gm. per kilogram. The method of restraint is of importance. In pigs up to 40 kg. both hind legs may be held up by an assistant, while in larger animals a single hind leg should be drawn up by a rope passed over a beam. The animal then takes his weight on his front legs and is in a semi-vertical position, which ensures that the abdominal wall is tense and easy of penetration with the needle, that the intestines tend to slip forwards and away from possible trauma, and that the narcotic, once injected into the peritoneal cavity, will gravitate towards the diaphragm, and recent work has shown that it is in this region that the maximum amount of absorption takes place. Very large or very quiet animals may be successfully injected in the standing position.

The site of the puncture in the semi-vertical position should be where a line drawn from the ischium to the elbow is met by a line coming from the middle of the hollow of the flank, while in the standing position the line should be drawn from the ilium; in this way the great nerves and vessels of the flank region are avoided. The apparatus required is very simple, comprising a gravity jar and an intravenous needle or trocar, the points of which should have been

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blunted. The two should be connected by a length of rubber tubing. After the usual preparation of the site with iodine the needle is inserted, and if clear of the intestines and their peristaltic movements it provides an easy and rapid inlet for the narcotic.

The author tested this method of inducing narcosis on 70 pigs, carrying out operations in 35 of them with every success. Narcosis ensues after 4-5 minutes without any period of excitement and lasts 30-75 minutes, according to the age and condition of the animal. The reflexes do not entirely disappear. There is no period of post-narcotic excitement, but narcosis is followed by sleep lasting 30-90 minutes and which is accompanied by shivering. The abdomen and its contents were examined in the case of the above-mentioned pigs 3-7 days after they had been narcotised in this manner, and no changes were found in them.

Meat from pigs killed during narcosis and in the post-narcotic stage was examined cooked and raw and found to have suffered no alteration in taste, colour, etc., nor to be toxic.

NEWS

Dr. W. R. Wooldridge, Scientific Director of the Animal Health Trust since 1942, has just been elected a Member of the Senate of London University. He is to represent the science graduates.

Dr. Wooldridge was born in London, S.W.4, and this honour has been conferred after an academic career which has included Governorship of the London School of Hygiene and Tropical Medicine, Birkbeck College, the Royal Veterinary College, Wye Agricultural College, and the National College of Food Technology.

He was educated at Sir Walter St. John's School, S.W., is a graduate of Birkbeck College and the Royal Veterinary College, London, and Gonville and Caius College, Cambridge. For a short while he was in veterinary practice in Reading.

Dr. Wooldridge is a past Centenary Medallist of the Royal Veterinary College, Veterinary Research Scholar of the Ministry of Agriculture, a Frank Smart Research Student of Caius College, and a Beit Memorial Fellow in Medical Research at Cambridge.

Now that the Royal Veterinary College is a school of the University, he hopes, among his other duties on the Senate, to advance the interests of veterinary science and to promote the well-being and increase the scope of veterinary students at the University in London.

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